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ORIGINAL

Final Technical Report Submitted to AFOSR: FY92-93 HBCU/MI Instrumentation for the Pulsed Power and Plasma Sciences Laboratory at the University of New Mexico (Grant AFOSR #F49620-93-1-0585)

30 November 1994

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I. Executive Summary

The Pulsed Power & Plasma Science Laboratory at the University of New Mexico (UNM) is pleased to have equipped its laboratory with modern instrumentation in support of its AFOSR-funded program on high power microwave sources. The instrumentation acquired can be broken broadly into three categories:

1. Microwave measurement/calibration (network analyzer and components)
2. Data acquisition (digital oscilloscopes, computers, LabView)
3. High vacuum capabilities (turbo pumps, residual gas analyzer).

This report describes the instrumentation and how it is used in support of the research program.

II. List of Acquired Equipment

The next two pages provides a comprehensive list of equipment that was purchased on this grant, and highlights minor deviations from the AFOSR-approved modified list of equipment (included as Appendix A to this report).

	Network Scalar Analyzer			
HP 8757XC W/ Opt. 52B	20 GHz Coxial Synthesized Scalar System	$36,225.00		
Opt 002	Internal Power Cal	$2,250.00		
Opt 001	Fourth Detector Input	$1,440.00		
			$39,915.00	
HP 85037B	Precision Detector	$1,665.00		
HP 85025E	AC/DC Detector	$1,080.00		
HP 11679B	Detector Cable 200 ft	$337.50		
HP 85025E	AC/DC Detector	$1,080.00		
HP 85027E	Directional Bridge	$2,853.00		
HP 11679A	3 Detector Cables 25 ft	$337.50		
			$7,353.00	
HP 85023B	Verification Kit for SMA	$900.00		
HP 85023C	Verification Kit for Type-N	$630.00		
HP 11636B	Power Divider	$945.00		
HP 11667B	Power Spiltter	$963.00		
			$3,438.00	$50,706.00
	Oscilloscopes			
TDS 320	3 Digital Oscilloscope 2 Ch, 500 Ms/s with GPIB bus	$8,456.00		
TDS 350	2 Digital Oscilloscope 2 Ch, 1Gs/s with GPIB bus	$7,184.00		
	Thermal Printer for Scope	$180.56		
TDS 644A	3 Color Digital Oscilloscope 4 Ch, 2 Gs/s	$45,145.80		
				$60,966.36
	Computers and DAQ			
	Mac IIfx with 20 Meg RAM and 300 MB Hard Drive	$2,987.98		
	Optical Drive	$964.40		
	HP 550C Deskwriter Printer	$539.97		
	LabView 3.0 for Mac	$1,296.75		
	NB-GPIB Board w/cable	$539.38		
	Thick Net Adapter	$70.38		
	Digital I/O Board	$319.50		
	Connecting Block and Cables	$216.00		
			$6,934.36	
	486DX2 System With 540MB Hard Drive, 16MB RAM 21" SVGA Monitor Optical Drive, Tape Backup	$6,370.00		
	Optical discs (10)	$329.80		
	LabView3.0 for Windows	$1,296.75		
	GPIB Board	$539.37		
	Digital I/O Board	$355.50		
	Connecting Block	$138.79		
	HP 560C Deskjet Printer	$546.44		
			$9,576.65	$16,511.01
	Turbo Pumps			
	Turbo Pump	$11,175.26		
	Controller for Turbo Pump	$5,780.00		$16,955.26
	Gas Analyzer			
	Residual Gas Analyzer	$7,500.00		
	Analyzer Head	$1,570.00		$9,070.00
	Total			$154,208.63

Differences:

Oscilloscopes: TDS 544A did not meet our requirements
therefore, we ordered three TDS 644A's.
Computers and DAQ:
Did not get DAQ software - used other funds
to buy Quatro Pro and Paradox Software
Used other funds to buy Ethernet cards ($150)
Upgraded to 21" Monitor for 486 system

III. Description of Research Program

The present AFOSR-funded grant on high power microwave sources has three research components:

1. High efficiency vacuum backward-wave oscillators
2. Long pulse vacuum and plasma-filled backward-wave oscillators
3. Ferroelectric cathodes for high power microwave sources.

The microwave measurement/calibration equipment is used on the two backward-wave oscillator (BWO) experiments, the data acquisition is used on all three components of the research program, and the high vacuum equipment is used on the long pulse BWO and on the ferroelectric cathode experiments.

In order to better describe the instrumentation, it would be useful to display photographs of the three experiments, and photographs of some of the acquired equipment.

Sinus-6 experiments

The study of high efficiency vacuum BWOs is performed on the Sinus-6 experiment (Fig. 1). This experiments uses LabView 3.0 to acquire and process the data that is taken with the digital oscilloscopes. In addition, the network analyzer is used to calibrate all of the microwave diagnostics and is used as a local oscillator to mix with the generated microwaves in a heterodyne scheme to measure frequency (Figs. 2-3).

These instruments were used to acquire and analyze the data that was used in a recent publication by our group.[1] It is essential to state that the data and understanding presented in this paper would not have been possible without the updated equipment.

Long pulse BWO experiments

The study of long pulse vacuum and plasma-filled backward-wave oscillators is performed using a modified PI-110A electron beam accelerator (Fig. 4, top).

This experiment utilizes the data acquisition instrumentation. In addition, it will use the turbo pump and the gas analyzer when it operates at higher power levels than the present time.

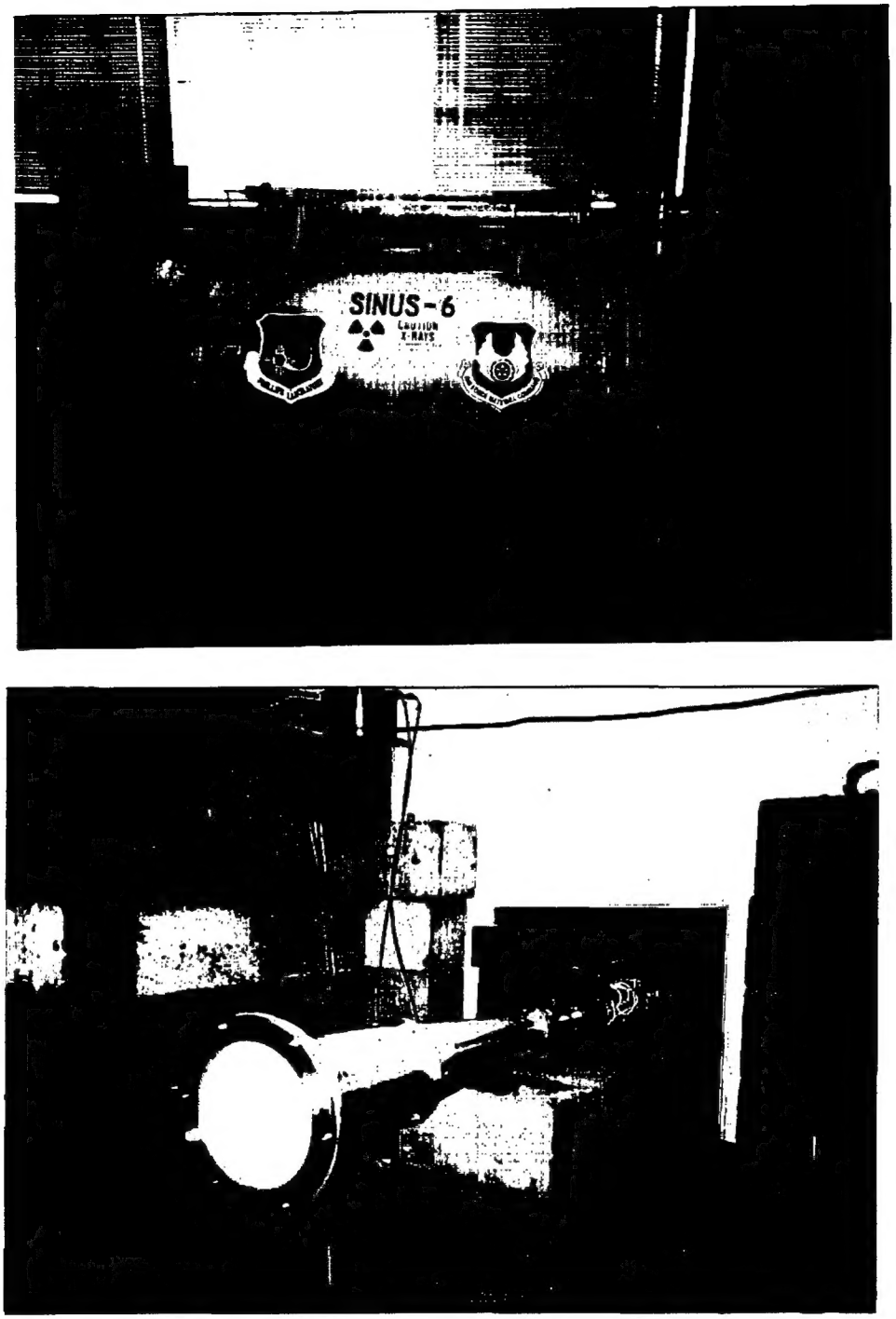


FIG. 1. Photograph of Sinus-6 repetitively-pulsed electron beam accelerator (top) and output of BWO microwave source (bottom).

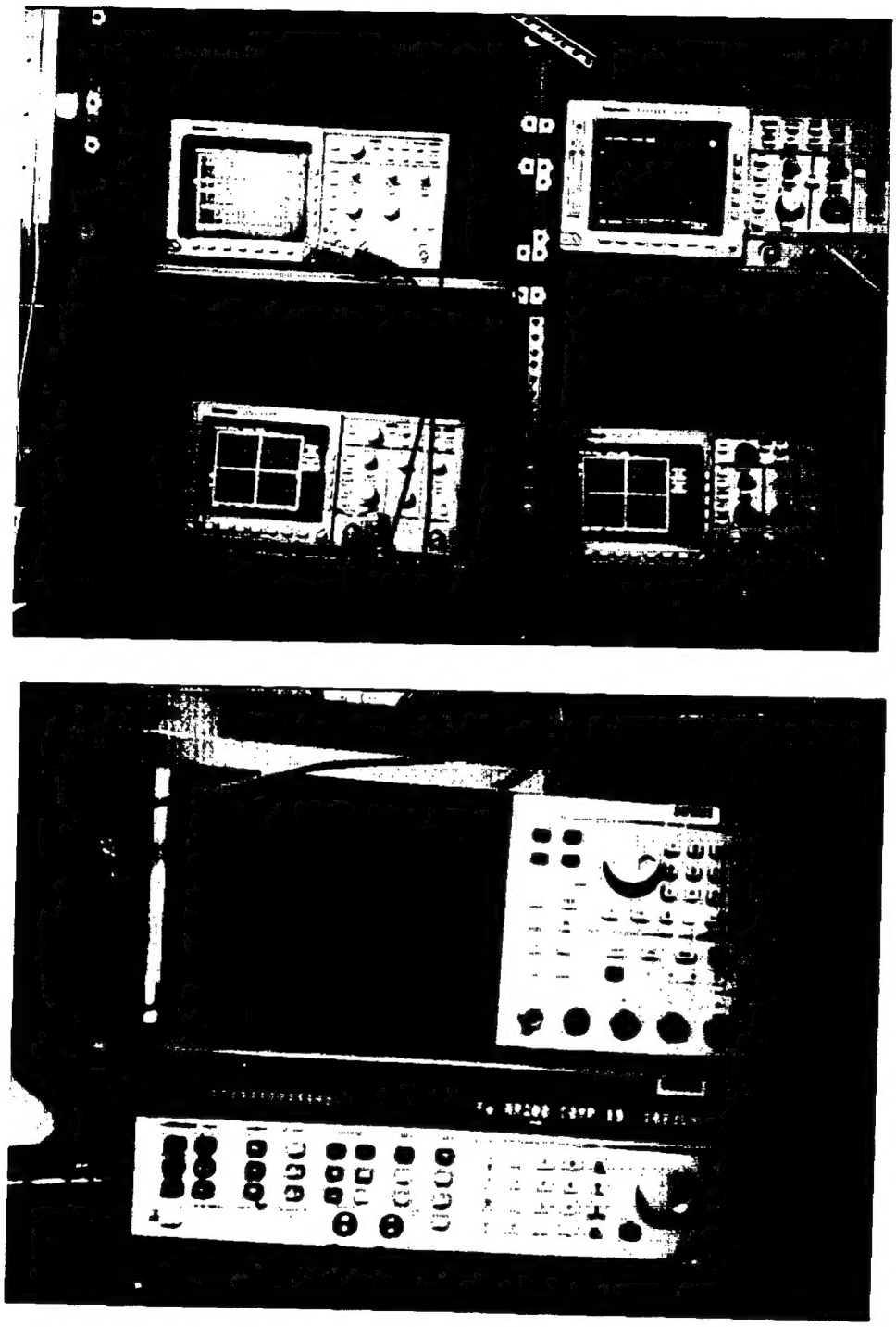
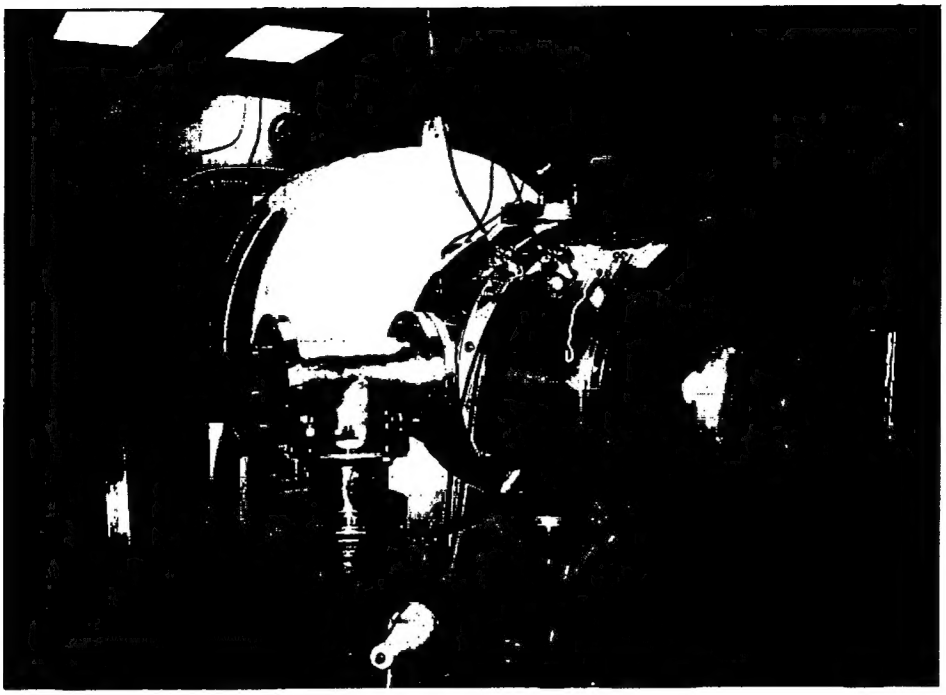


FIG. 2. Array of four digital oscilloscopes (top) and network analyzer (bottom).

FIG. 3. Photograph of screen room showing the computer, digital oscilloscopes, and network analyzer (top). Doctoral candidate Larald Moreland analyzing a shot using LabView (bottom).



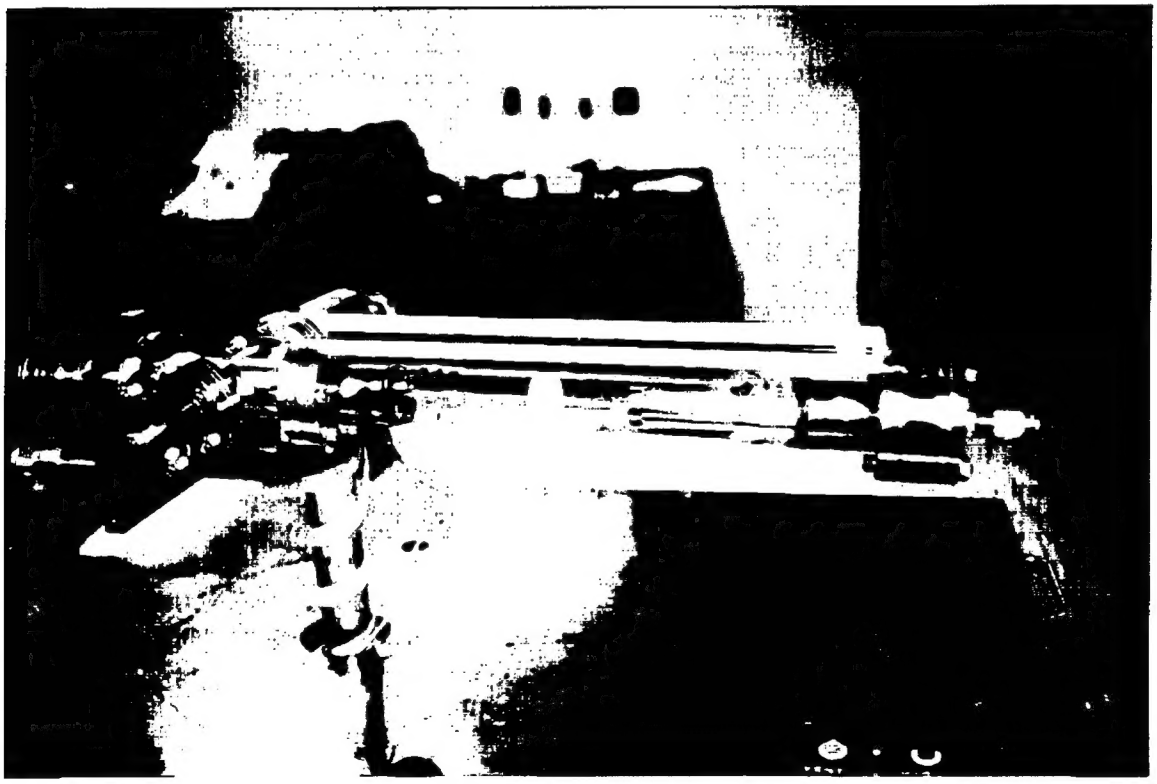


FIG. 4. Photograph of long pulse BWO (top) and ferroelectric cathode test stand (bottom).

Ferroelectric cathode devevelopment

This experiment utilizes the high vacuum equipment as well as the data acquisition equipment. The ferroelectric cathode test stand is shown in Fig. 4, bottom. The results published in a recent paper[2] used the data acquisition equipment. The residual gas analyzer will be of particular use to this experiment since it will look for evidence of neutrals and plasmas emanating from the cathode periphery. It is important to document whether the ferroelectric electron emission mechanism is accompanied by plasma-based effects.

IV. References

1. L. D. Moreland, E. Schamiloglu, R. W. Lemke, S. D. Korovin, V. V. Rostov, A. M. Roitman, K. J. Hendricks, and T. A. Spencer, "Efficiency Enhancement of High Power Vacuum BWO's Using Nonuniform Slow Wave Structures," IEEE Trans. Plasma Sci. **22**, 554 (1994).

2. T. C. Cavazos, W. L. Wilbanks, C. B. Fleddermann, and D. A. Shiffler, "Repeatable electron emission from (Pb,La)(Zr,Ti)O_3 ferroelectric cathodes using direct-current reset," Appl. Phys. Lett. **65**, 2612 (1994).